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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/784,903	02/20/2004	A. Farid Issaq	ACT-390	6148
28661	7590	09/15/2005	EXAMINER	
SIERRA PATENT GROUP, LTD.			NADAV, ORI	
P O BOX 6149			ART UNIT	
STATELINE, NV 89449			PAPER NUMBER	
			2811	
DATE MAILED: 09/15/2005				

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/784,903

Applicant(s)

ISSAQ ET AL.

Examiner

Ori Nadav

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 August 2005.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-35 and 40-46 is/are pending in the application.
- 4a) Of the above claim(s) 35 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-34 and 40-46 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>5/24/04, 5/26/04</u> | 6) <input type="checkbox"/> Other: _____ |

Election/Restrictions

Applicant's election without traverse of Group I, drawn to a reprogrammable metal-to-metal anti-fuse, in the reply filed on 08/02/2005 is acknowledged.

Claim Objections

Claims 1-22 are objected to because of the following informalities: The phrase "lower adhesion-promoting layer lower Ti barrier layer", as recited in claim 1, should read "lower adhesion-promoting layer and lower Ti barrier layer". Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 41 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The claimed limitation of a more negative value above said antifuse material layer, as recited in claim 41, is unclear as to how a negative value can be above an antifuse material layer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-2, 13, 16, 23, 29 and 40-46 are rejected under 35 U.S.C. 103(a) as being unpatentable over McCollum (5,789,764) in view of Takagi et al. (5,550,400).

Regarding claims 1 and 23, McCollum teaches in figure 7C and related text a reprogrammable metal-to-metal antifuse comprising:

- a lower metal interconnect layer 82;
- an inter-metal dielectric layer 84 disposed over said lower metal interconnect layer, said inter-metal dielectric layer having a via formed there through and filled with a metal plug 88;
- a lower adhesion-promoting layer 90 disposed over said lower metal layer layer;
- an antifuse material layer 92 disposed above an upper surface of said lower adhesion-promoting layer, said antifuse material layer selected from a group comprising at least one of amorphous carbon and amorphous carbon doped with at least one of hydrogen and fluorine disposed over said lower adhesion-promoting layer;
- and an upper adhesion-promoting layer 94 disposed over said antifuse material layer.

McCollum does not teach lower and upper Ti barrier layers disposed under and over said upper adhesion-promoting layers.

Takagi et al. teach in figure 2 lower and upper Ti barrier layer and lower and upper adhesion-promoting layers 20, 8 (Ti/TiN) disposed under and over an antifuse. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use lower and upper Ti barrier layer and lower and upper adhesion-promoting layers (Ti/TiN) under and over the antifuse in McCollum's device in order to improve the adhesion of the layers in the device.

Regarding claims 2, 13, 16 and 29, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use said lower adhesion-promoting layer and said upper adhesion-promoting layer each with a thickness of between about 2 angstroms and about 20 angstroms, and said antifuse material layer having a thickness of between about 50 angstroms and about 500 angstroms, in McCollum's device in order to optimize the device characteristics according to the requirements of the application in hand.

Regarding claims 40, 41, 43 and 46, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to program and erase a reprogrammable metal-to-metal antifuse, by programming said antifuse by applying a programming potential across said antifuse to cause a programming current to flow through said antifuse until its resistance substantially decreases; and erasing said antifuse by applying an erasing potential across said antifuse, said erasing potential being lower in magnitude than said programming potential and causing an erase current

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to flow through said antifuse, wherein programming said antifuse also includes soaking said antifuse by passing a soak-current through said antifuse, and applying a potential having a more negative value above said antifuse material layer, in prior art's device in order to operate the device in its intended use.

Regarding claims 42 and 44-46, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a programming current in a range of between about 0.1 to about 1mA, wherein said soak-current has a magnitude of about 5mA, wherein said programming current is less than about 1mA and a ratio of said erase current to said programming current is about 10:1, and wherein a ratio of said erase current to said soak current is about 3:1 in prior art's device in order to optimize the device operation.

Claims 14-15 and 30-31 are rejected under U.S.C. 103(a) as being unpatentable over McCollum and Takagi et al., as applied to Claims 1-2, 13, 16, 23 and 29, and further in view of Liu et al. ("A New Metal-to-Metal Antifuse with Amorphous Carbon," IEEE Electron Device Letters, Vol. 19, No. 9, (1998), pp. 317 - 319).

McCollum and Takagi et al. teach substantially the entire claimed structure, as applied to claims 1-2, 13, 16, 23 and 29 above, except an antifuse material layer doped with hydrogen in a concentration range of about 1 atomic percent to about 40 atomic percent.

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Liu et al. disclose (p. 317, right side, first paragraph) that amorphous carbon is used with hydrogen and fluorine doping as an antifuse element. It would have been obvious to one of ordinary skill in the art at the time of the invention to use an antifuse material layer doped with hydrogen in a concentration range of about 1 atomic percent to about 40 atomic percent in Mccollum and Takagi et al.'s device in order to reduce ON-OFF switching and leakage currents (Liu et al., page 318, left side, 2nd paragraph, page 319, conclusion).

Claims 1-3, 6-8, 11-17, 20-22, 29, 34 and 40-46 are rejected under U.S.C. 103(a) as being unpatentable over Forouhi (5,181,096) in view of Liu et al.

Regarding claims 1, 3, 6-8, 11-12, 14-1, 17, 20-22 and 34, Forouhi teaches in figure 1 and related text a reprogrammable metal-to-metal antifuse comprising:

- a lower metal interconnect layer 16;

- a lower Ti barrier layer 18 disposed over said metal layer;

- a lower silicon nitride adhesion-promoting layer 20 disposed over said lower Ti barrier layer;

- an antifuse material layer 22 disposed above an upper surface of said lower adhesion-promoting layer and lower Ti barrier layer,

- an upper silicon nitride adhesion-promoting layer 24 disposed over said antifuse material layer; and

- an upper Ti barrier layer 28 disposed under and over said upper adhesion-promoting layer.

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Forouhi does not teach said antifuse material layer selected from a group comprising at least one of amorphous carbon and amorphous carbon doped with at least one of hydrogen and fluorine.

Liu et al. teach an antifuse material layer selected from a group comprising at least one of amorphous carbon and amorphous carbon doped with at least one of hydrogen and fluorine.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use an antifuse material layer selected from a group comprising at least one of amorphous carbon and amorphous carbon doped with at least one of hydrogen and fluorine in McCollum's device in order to improve the characteristics of the device. The combination is motivated by the teachings of Liu et al. who point out the advantages of using an antifuse material layer comprising an amorphous carbon over an antifuse comprising silicon nitride and amorphous silicon.

Regarding claims 2, 13, 16 and 29, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use said lower adhesion-promoting layer and said upper adhesion-promoting layer each with a thickness of between about 2 angstroms and about 20 angstroms, and said antifuse material layer having a thickness of between about 50 angstroms and about 500 angstroms, in Forouhi and Liu et al.'s device in order to optimize the device characteristics according to the requirements of the application in hand.

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Regarding claims 40, 41, 43 and 46, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to program and erase a reprogrammable metal-to-metal antifuse, by programming said antifuse by applying a programming potential across said antifuse to cause a programming current to flow through said antifuse until its resistance substantially decreases; and erasing said antifuse by applying an erasing potential across said antifuse, said erasing potential being lower in magnitude than said programming potential and causing an erase current to flow through said antifuse, wherein programming said antifuse also includes soaking said antifuse by passing a soak-current through said antifuse, and applying a potential having a more negative value above said antifuse material layer, in prior art's device in order to operate the device in its intended use.

Regarding claims 42 and 44-46, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a programming current in a range of between about 0.1 to about 1mA, wherein said soak-current has a magnitude of about 5mA, wherein said programming current is less than about 1mA and a ratio of said erase current to said programming current is about 10:1, and wherein a ratio of said erase current to said soak current is about 3:1 in prior art's device in order to optimize the device operation.

Claims 23-24 and 27-32 are rejected under U.S.C. 103(a) as being unpatentable over Forouhi and Liu et al., as applied to claims 1-2 and 14-15 above, and further in view of McCollum

Forouhi and Liu et al. teach substantially the entire claimed structure, as applied to claims 1-2 and 14-15 above, except an inter-metal dielectric layer disposed over said lower metal interconnect layer, said inter-metal dielectric layer having a via formed there through and filled with a metal plug.

McCollum teaches in figure 7C and related text an inter-metal dielectric layer 84 disposed over said lower metal interconnect layer, said inter-metal dielectric layer having a via formed there through and filled with a metal plug 88;

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use an inter-metal dielectric layer disposed over said lower metal interconnect layer, wherein said inter-metal dielectric layer having a via formed there through and filled with a metal plug in Forouhi and Liu et al.'s device in order to use the device in a practical application.

Claims 4-5, 9-10, 18-19 and 33 are rejected under U.S.C. 103(a) as being unpatentable over Forouhi and Liu et al., as applied to claims 1 and 3 above, and further in view of Han (6,583,953).

Forouhi and Liu et al. teach substantially the entire claimed structure, as applied to claims 1 and 3 above, except adhesion-promoting layers comprising SiC.

Han teaches in figure 4 and related text an adhesion-promoting layer comprising SiC (column 4, lines 21-24).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use an adhesion-promoting layers comprising SiC in prior art's device in order to improve the device characteristics. Note that substitution of materials is not patentable even when the substitution is new and useful. *Safetran Systems Corp. v. Federal Sign & Signal Corp.* (DC NIII, 1981) 215 USPQ 979.

Claims 25-26 are rejected under U.S.C. 103(a) as being unpatentable over Forouhi, Liu et al. and McCollum, as applied to claim 23 above, and further in view of Han.

Forouhi, Liu et al. and McCollum teach substantially the entire claimed structure, as applied to claims 1 and 3 above, except adhesion-promoting layers comprising SiC. Han teaches in figure 4 and related text an adhesion-promoting layer comprising SiC (column 4, lines 21-24).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use an adhesion-promoting layers comprising SiC in prior art's device in order to improve the device characteristics. Note that substitution of materials is not patentable even when the substitution is new and useful. *Safetran Systems Corp. v. Federal Sign & Signal Corp.* (DC NIII, 1981) 215 USPQ 979.

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The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Reference B is cited as being related to antifuse.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ori Nadav whose telephone number is 571-272-1660. The examiner can normally be reached between the hours of 7 AM to 4 PM (Eastern Standard Time) Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Loke can be reached on 571-272-1657. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



O.N.
9/12/05

ORI NADAV
PRIMARY EXAMINER
TECHNOLOGY CENTER 2800